The Effects of Interactive and Noninteractive Pictures on Cue Function with Retarded Subjects

by

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Introduction

When engaged in a learning task in which the formation of stimulus-response associations is required, a subject may utilize only a part of the stimulus instead of the entire stimulus configuration in the formation of these associations. For example, given the stimulus complex AB which is to elicit the response R, a subject may utilize either A or B as his functional stimulus rather than the entire complex (AB). The analysis of this process and those variables which influence this process is termed the study of cue selection.

Although a large amount of research exists regarding the cue selection habits of normals and retardates, little is known about the development of cue selection habits within each of these groups. Recent research conducted by Hale and Morgan (1975) suggests that the development of cue processing in persons of normal intelligence may be characterized by an increasing tendency with mental age to use secondary stimulus components in the acquisition of stimulus-response associations. One purpose of the present study was to replicate this finding of the Hale and Morgan study, with a particular interest in determining if retardates exhibit a similar pattern of cue processing development.

A second purpose of the present study was to assess the effects of stimulus-component interaction on cue selection in a PA task. A number of studies, among them Milgram (1967), Reese (1965), and Rohwer, Lynch, Suzuki, and Levin (1967), have found that PA lists in which the stimulus and response items are pictorially depicted in an interactive context, for example, a boy pulling a wagon, are learned more quickly than PA lists in which the stimulus and response items are pictorially depicted in a noninteractive context, for example, a boy and a wagon (side by side). In other words, depicting pictorial stimulus and response items in an interactive relationship facilitates the formation of associations between these items. Assuming that similar processes underlie the formation of associations between the components of pictorial stimuli, one would expect that the depiction of such components in an interactive relationship in PA task would have a similar effect upon the formation of associations between these components. The result of such an effect should be to encourage greater use of both stimulus components in a learning task.

Review of the Literature

Underwood, Ham, and Ekstrand (1962) were the first to formally propose and test the hypothesis that subjects, when presented with a compound stimulus in a verbal learning task, may select one component of that compound as their functional stimulus. To test this hypothesis, Underwood *et al*. had two groups of subjects learn different paired-associates (PA) lists. One group of subjects (CW) learned a list in which the stimuli were words on distinctive colored backgrounds, while the other group of subjects (CT) learned a list in which the stimuli were trigrams (nonsense syllables) on distinctive colored backgrounds.

Following learning of the two lists, each group of subjects was divided into three subgroups. One of the three groups continued on the original PA list with compound stimuli. The remaining two groups were transferred to PA tasks in which the stimuli were either one or the other components of the former compound stimuli. The responses remained unchanged. Thus, in transfer the subjects of group CW either continued on the original word + color PA task, or were transferred to word-digit or color-digit PA tasks. The subjects of group CT, on the other hand, either continued on the original color + trigram digit PA task, or were transferred to either color-digit or trigram-digit PA tasks.

For the CW subgroups, relearning performances of the word + color-digit and word-digit groups was equivalent and superior to that of the color-digit group, suggesting a greater dependence on word than color components during first list learning. For the CT subgroups, relearning performances of the trigram + color-digit and color-digit groups was equivalent and superior to that of the trigram-digit group, suggesting a greater reliance on the color than trigram component during first list learning. Underwood et al. concluded that the subjects of both groups (CW and CT) had selected the more meaningful of the two stimulus components (words and colors, respectively) as their functional stimuli during first list learning.

The findings of Underwood et al. (1962) with both color + word compound stimuli and color + trigram compound stimuli have been replicated many times (e.g., Berry & Baumeister, 1971a; Kroll & Grant, 1968; Houston, 1967; Jenkins & Bailey, 1964; Spear, Ekstrand & Underwood, 1964), and it is now well-established that subjects under certain circumstances will utilize a single component of a compound stimulus as their functional stimulus.

Variables Which Affect Cue Selection

Stimulus-component meaningfulness. Numerous variables have been found to affect cue selection . One of the earliest variables studied was stimulus-component meaningfulness. Underwood et al. (1962) concluded that their subjects had selected the more meaningful components of the stimulus compounds as their functional stimuli. While it seems logical to assume that colors are more meaningful than trigrams, as responding to colors is in all likelihood mediated by color names (see Jenkins & Bailey, 1964), the assumption that words are more meaningful than colors is less compelling.

Cohen and Musgrave (1964) pointed this out and tested the proposal that subjects, when presented with a compound stimulus in which the components differed in meaningfulness as measured by operationally defined procedures (Archer, 1960), would select the more meaningful component as their functional stimulus. Duplicating the procedure of Underwood et al. (1962), Cohen and Musgrave first had subjects learn a PA task in which the stimuli were high- and low-meaningful consonant-vowel-consonant (CVC) trigram compounds, and then transferred them to one of two PA lists in which the stimuli were either the high- or low-meaningful CVC trigrams of the first list; the responses remained unchanged. In transfer, performance was significantly better for those subjects relearning the list with high-meaningful trigrams as stimuli, indicating that the subjects had, indeed, selected the high-meaningful stimulus components as their functional stimuli. The proposal of Underwood, Ham, and

Ekstrand was supported. This finding has been reported several times (e.g., Berry & Baumeister, 1971a; Lovelace, 1968; Spear, Ekstrand, & Underwood, 1964; Young, Teeters, & Zelazny, 1966).

Stimulus-component position. As might be expected from reading habits (i.e., left to right), the position of the stimulus components also influences stimulus selection. Cohen and Musgrave, in the study above (1964), and in a later study (1966), demonstrated that when subjects were first required to learn a PA task in which the stimuli were compounds, and then were transferred to a task in which the stimuli were either the left or right stimulus components of the first task, subjects receiving the left components performed better than those receiving the right components. Similar results have been obtained by Lovelace (1968) with two-component stimuli and by Jenkins (1963) and Baumeister and Berry (1970) with three-component stimuli.

Instructions. Because cue selection may be a result of differential attention to the various stimulus components of a stimulus compound, it would seem reasonable to expect that instructions, which direct attention to various stimulus components, might alter the focus of attention thereby influencing cue selection. One of the first investigators to assess the effects of instructions on cue selection was Houston (1967). Houston had four groups of subjects learn a color + trigram-digit

PA list under differing instructions. One group was instructed that they would be tested on the color element, one was instructed that they would be tested on the trigram element, another was instructed that they would be tested on both colors and trigrams, and a fourth received no special instructions. Both relearning (to components) and recall measures were obtained following first list learning. As expected, both measures indicated increased selection (relative to the no-instructional control group) of the instructed component. Other studies (Baumeister, Berry, & Forehand, 1969; Schneider & Houston, 1968, 1969) have obtained similar results.

Discriminability of stimulus components. If subjects are presented with a PA task in which one set of stimulus components facilitates discrimination among the various stimuli and the other set of components does not, subjects will rely on those components which facilitate discrimination among the stimuli. For example, Cohen and Musgrave (1966), after presenting subjects with a PA list in which the stimuli were composed of high- or low-similarity CVC components, found that the subjects relied heavily on the low-similarity components. Similarly, when Newman and Taylor (1963) required subjects to learn PA lists with stimuli composed of either high- or low similarity CVC's plus distinctive colors, subjects tended to rely on colors when the verbal components were the high-similarity CVC's. However, the effect does not seem to hold if the verbal components are well-integrated, for example, words (Lockhart, 1968).

Component saliency. Cue saliency also seems to be a potent factor in cue selection. Harrington (1969) has demonstrated with word + CVC and high + low meaningful CVC stimulus compounds, that coloring one of the two components will increase selection of that component. Rabinowitz and Robe (1966) and Rabinowitz and McClinton (1971) in a similar manner, increased selection of various letters of consonant-consonant-consonant (CCC) stimulus compounds.

Jacobus and Leonard (1968) and Leonard and Jacobus (1969) had subjects learn PA lists in which the stimuli consisted of either two or three adjectives varied along a distinctiveness dimension. Distinctiveness was defined in terms of the results of a short-term, recognition-memory study, with distinctiveness being the difference between hits (old words called old) and false alarms (new words called old). Following lists learning, response recall to the high-distinctiveness adjectives was superior to that of adjectives of lower distinctiveness.

Integration of stimulus components. Single-component selection is less likely to occur if a stimulus compound is well integrated than if it is not. Lovelace and Blass (1968) found that subjects would normally utilize an entire trigram as the functional stimulus if it was a CVC, but would select a single letter if the trigram was a CCC.

Simarily, Postman and Greenbloom (1967), using stimuli of either hard- or easy-to-pronounce CVC's, found that subjects would usually select a single letter as their functional stimulus if the CVC was hard-to-pronounce, but would use the entire trigram if it was easy-to-pronounce.

Degree of original learning. Some researchers, but not all, have found that cue selection is influenced by the degree of learning. Houston (1967), one of the first to advance this hypothesis, suggested that early in PA learning the amount of single-component selection is considerable allowing prompt mastery of the list, but that, following list mastery, the amount of single-component selection decreases allowing additional components to become learned. Houston tested this hypothesis by presenting subjects with a color + trigram-digit PA list for either 1, 3, 12, or 20 anticipation trials, following which they were required to recall the correct response to either the color, trigram, or color + trigram stimuli. Although selection of colors did occur, as more correct recalls were made to colors than to trigrams, the relative amount of color selection did not vary across trials as had been expected.

Two similar studies performed by Lovelace and Blass (1968), who used three-letter (CCC and CVC) stimulus compounds, and Leight and Kausler (1965), who used high- and low-meaningful CVC stimulus compounds, obtained results similar to those of Houston. That is, they found that the relative amount of single-component selection did not vary across trials.

James and Greeno (1967) did obtain support for Houston's hypothesis. Using a PA task with three-letter word and CVC trigram stimulus compounds, James and Greeno (Experiments I and II) required subjects to reach a learning criterion of either four-of-eight correct responses, one perfect trial, or one perfect trial + 10 overlearning trials. Following attainment of the learning criterion, subjects were presented with a transfer task to determine the amount of single-stimulus selection which had occurred. They found, as expected, that words were the selected component, and that the frequency of word selection increased from early in learning (four-of-eight correct responses) to list mastery (one perfect trial), but decreased following 10 overlearning trials.

The three studies mentioned above all used a single criterion for inferring single-component selection: superior response recall to one component, as opposed to the other(s), following PA learning with compound stimuli. The two studies described below--Berry, Joubert, and Baumeister (1971) and Davis, Brown, and Ritchie (1968)--used the double-criterion developed by Postman and Greenbloom (1967) for inferring single-component selection. The two criteria are: 1) the subject must recall the correct response to a single component and 2) the subject must fail to recall the remaining component(s). This dual criterion for inferring single-cue selection is intended to rule out mediation of the correct response to non-selected components.

Berry, Joubert, and Baumeister (1971), using a modification of Postman and Greenbloom's procedure, looked not only at single-letter selection following different degrees of PA learning, but also at two- and three-letter selections. For example, if a subject could recall the correct response to two letters of CCC compound following list learning, but not to the third, two-letter selection was inferred. Three-letter selection was inferred in a similar manner. Berry et al. found that the percentage of single-letter solutions (i.e., the percentage of PA pairs solved through use of single-letter selections) remained fairly stable across trials. There was a shift, however, from second- and terminal-letter selection to first letter selection. The percentage of two-letter solutions, on the other hand, increased across trials. There was also a slight increase in the percentage of three-letter solutions.

Berry and his associates also applied the single-criterion scoring technique (that used by Houston, 1967; Leight & Kausler, 1965; Lovelace & Blass, 1968) to the data. The results of single-criterion scoring, in contrast to the results of double-criterion scoring, indicated an increase in first-letter selection until list mastery, followed by an increase in third-letter selection during overlearning. These results would seem to corroborate the finding of James and Greeno (1967).

Davis, Brown, and Ritchie (1968), like James and Greeno (1967) and Berry et al. (1971), obtained significant variation of stimulus selection across trials. The study of Davis et al., however, differed from the other two studies in that response similarity was an experimental variable. Davis et al. found that with low-similarity responses and CCC stimuli, single-letter selection first increased, then decreased following list mastery. With high-similarity responses, however, there was a continual increase in single-letter selections across trials. Davis et al. also studied two- and three-letter selections. The results they obtained with their low response-similarity groups were very similar to those obtained by Berry et al.

Differences in scoring and learning criteria make it difficult to draw conclusions regarding the effect of the degree of learning on cue selection. However, it would appear that double-criterion scoring is a more sensitive measure of this effect than single criterion scoring, as it enables an assessment of multiple-component selection. Furthermore, those studies (Berry et al., 1971 and Davis et al., 1968) using this measure have obtained similar results.

Response characteristics. Stimulus components which are easily associated with the responses are usually selected by subjects. Solso, in two studies (1968a,b), required subjects to learn PA lists in which the stimuli were color + trigram compounds and the responses either words which were color associates or neutral. Learning was much faster for those subjects receiving color associates as responses than for those subjects receiving neutral responses, suggesting a large degree of color selection.

Retrieval interval. Although cue selection has been found to be relatively invariant across various study intervals (Lovelace & Greenberg, 1969; Rabinowitz and Robe, 1966), it has been found to change as a result of manipulations in the length of the test, or retrieval, interval. Baumeister and Kistler (1974) found that subjects allowed a 6-second retrieval interval in a PA task using the study-test method engaged in more single-stimulus selection than subjects allowed a 2-second retrieval interval. The authors suggested that subjects who were permitted only a short time for retrieval fail to adopt an active cue selection strategy.

The Effects of Stimulus Compounding on the Acquisition and Retention of PA Lists

The major finding of current studies concerning the effect of stimulus compounding on PA acquisition has been that adding components which are as, or more, difficult to associate with the responses than the primary components does not facilitate learning, whereas adding components which are easier to associate with the responses than the primary components does facilitate learning. For example, Baumeister et al., (1969, Experiment I), Saltz (1963, Experiment I), and Swede and McNulty (1967) have all shown that PA lists with color + trigram stimuli are more easily learned than PA lists with only trigrams as stimuli. Baumeister and Berry (1968) and Sundland and Wickens (1962), on the other hand, observed that the acquisition of PA lists with single words as stimuli was not facilitated by the addition of color context.

These findings are not surprising if one considers, for a moment, some of the variables which have been found to affect cue selection, for example, meaningfulness, stimulus integration, response characteristics, and discriminability. In each case the subject tends to select that component which reduces list difficulty.

One might think, on an intuitive basis, that, following equivalent amounts of PA learning with and without context cues, response recall would be superior for those subjects learning and recalling under compound stimulus conditions, as these subjects have additional cues available to elicit recall. Oddly enough, although numerous studies have investigated the effect of context removal on recall (e.g., Dulsky, 1935; Swede & McNulty, 1967; Weiss & Margolius, 1954), only two studies have compared the recall responses of subjects learning <u>and</u> recalling under compound- and single-stimulus conditions.

Swede and McNulty (1967) had subjects learn PA lists under four different stimulus conditions: trigram + color, trigram + shape, trigram + shape + color, and trigram alone. PA learning was taken to a criterion of one perfect trial, following which subjects were required to recall under condition of either context (trigrams + color and/or shape) or no context (trigrams alone). The authors found that, as long as the recall context was the same as the learning context, there was no difference in the amount recalled.

The study would, then, seem not to support the hypothesis of superior recall to compound stimuli. However, an important difference exists between this study and the study of Hill and Wickens (1962), to follow, which did obtain support for the hypothesis. Swede and McNulty equated subjects on performance level (i.e., one perfect trial) prior to recall, whereas Hill and Wickens did not. Requiring subjects to attain the same performance level would seem to reduce any differences which might have been produced by contextual variations.

Hill and Wickens (1962), rather than require subjects to attain the same performance level, equated study time among the various groups. One group received 10 learning trials with compound stimuli (colors + nonsense syllables) and were then tested on the combined stimuli. Two other groups received 10 learning trials with one or the other (i.e., colors or nonsense syllables) single stimuli and were then tested on the appropriate single stimuli. Recall was considerably better to the compound stimuli than to either of the single stimuli. The results of Hill and Wickens support the hypothesis that recall to compound stimuli is superior to that of single stimuli.

<u>How Do Context Cues Affect PA Learning?</u>

Two positions can be roughly delineated within the cue selection literature which attempt to explain what occurs during learning when compound stimuli are utilized in a PA task. One position which might, for want of a better word, be called the <u>cue</u> hypothesis, postulates that context stimuli facilitate learning because they serve as cues to elicit the correct responses. The context stimuli may be the primary cues, if these are selected, or they may merely serve as additional cues if they are not selected. This is essentially the position of Underwood <u>et al</u>. (1962), Birnbaum (1966a,b) and Greeno (1966a,b).

The other position, generally termed the differentiation hypothesis, holds that any improvement in learning which occurs as a result of the addition of contextual cues to the stimuli of a PA task is due to the increased differentiation of the primary stimuli. Since it is obviously necessary that subjects be able to differentiate stimuli prior to forming associations between stimuli and responses, the supposition is that predifferentiation reduces the amount of time required for a subject to differentiate between the stimuli, thus, decreasing learning time. The differentiation position was developed by Saltz and his associates (Saltz, 1963; Saltz & Ager, 1968; Saltz & Wickey, 1967) following the postulations of the cue selection hypothesis by Underwood et al. (1962).

To support the differentiation hypothesis, Saltz (1963, Experiment I) required subjects to learn a CVC-adjective PA list in which the context stimuli (colors) were present on study trials, but not on test trials. Thus, any facilitation of learning would be due to the differentiation properties of the context stimuli, and not to their cue properties. As Saltz predicted, learning was facilitated by the presence of contextual stimuli even though these were absent on the test trials.

Although Saltz did obtain support for his hypothesis, he recognized that even though the context stimuli were absent on test trials, they could still have facilitated learning via mediation (CVC:color:adjective). Saltz (1963, Experiment II), therefore, replicated his first experiment using primary stimuli (words) which were easier to associate with the responses than the contextual stimuli (colors). He reasoned that any attempt to utilize context stimuli as cues would not result in facilitation of list learning. Again, the results supported Saltz's hypothesis; learning was facilitated by the addition of color.

Birnbaum (1966a) pointed out that, even though Saltz had obtained facilitation of PA learning by using contextual stimuli which were more difficult to associate to the responses than the primary stimuli, it was still possible that mediation could have been responsible for the facilitation. For example, word:color:response mediation could have provided sufficient additional cues, over and above those provided by direct word-response associations, to have facilitated recall of the correct responses.

Birnbaum subsequently demonstrated (1966a,b) that associations had been formed between the primary and contextual stimuli. In one study (1966a), Birnbaum duplicated Saltz's original learning procedure using nonsense syllable + color compound stimuli. Subjects were required to learn a PA task in which the colors (contextual cues) were present on study trials but absent on test trials. After the subjects attained the learning criterion, Birnbaum then transferred them to a PA list consisting of the nonsense syllables as stimuli and colors as responses. For half the subjects the nonsense syllable-color pairing was inappropriate relative to first list learning, constituting an ABr paradigm. For the other half of the subjects, the pairing was appropriate, constituting an AB paradigm. The results indicated significantly superior performance for those subjects receiving the appropriate pairings, strongly suggesting that associations had been formed between the primary and contextual cues. In a second study (1966b), Birnbaum replicated these results with numbers as the primary stimuli and single letters as the contextual cues. Thus, one requirement for component-response mediation was met.

Although the results of the Birnbaum's studies suggest that component-component associations were formed, an alternative explanation is possible. The superior performance of those subjects receiving the PA list of appropriately-paired components could be attributed to component:response:component (S-R-S) mediation, rather than a direct component:component (S-S) association.

This position was taken by Wichawut and Martin (1968). Wichawut and Martin demonstrated that, following learning of a CCC-digit PA list and given one letter as a recall cue, the probability of recalling additional letters was near zero unless the response was also recalled. They concluded that S-R-S (i.e., component:response:component) mediation was responsible for the correct recall of additional letters, and that independent S-R associations had been formed independently between component and response elements.

Steiner and Sobel (1968) devised a unique test to differentiate between the S-S and S-R-S possibilities. They first presented subjects with a PA task consisting of word + color stimuli and single digits as responses.

Each response was paired with two stimuli. Thus, there were half as many responses as there were stimuli. After subjects had learned the list, they were presented with the words (primary stimuli) and asked to select the contextual stimuli (colors) with which they were paired from various combinations of three colors.

For example, in one recall condition one of the three colors was the correct color. If the subject selected this color (i.e., the correct color) he could have done so as a result of a direct component-component (S-S) association, component:response:component (S-R-S) mediation, or a guess. Another of the three colors was associated with a different word, but with the same response. If the subject selected this color, he could have done so only as a result of S-R-S mediation or a guess. A third color was incorrect and not associated with the same response. Should a subject select this color, he could have done so only as the result of a guess.

One can see that, by the proper pairings of words and colors, this procedure enables one to determine the extent to which S-S associations and/or S-R-S mediation occurred. The results overwhelmingly supported direct S-S associations as responsible for the correct component-component matches.

Further support for the mediation hypothesis of Birnbaum comes from a study by Berry and Baumeister (1971a). Berry and Baumeister taught retardates a word + trigram-digit PA list, following which they were subdivided into three groups. One group, the control group, was shown the compound (word + trigram) stimuli and asked to recall the responses. A second group was shown the words alone and asked to recall both the trigrams with which they were matched and the correct response. A third group was shown the trigrams and asked to recall the associated words and the correct responses.

They found that, in every instance where the response was correctly recalled to a word, the subject was unable to recall the associated trigram. Conversely, where the response was correctly recalled to a trigram, the subject could nearly always recall the associated word. Berry and Baumeister (1971b) concluded that these results imply a selection of the more meaningful cues, words, and an incidental acquisition of the less meaningful cues, trigrams, through contiguous association.

The results of these studies, then, would seem to favor the cue position of Underwood _et al_. (1962), Birnbaum (1966a,b), and Greeno (1966a,b), as opposed to the differentiation position of Saltz and his associates (Saltz, 1963; Saltz & Ager, 1968; Saltz & Wickey, 1967).

Methodological Advances in the Measurement of Cue Selection

Early studies of cue selection typically demonstrated selection in one of two ways: either 1) by demonstrating that, following learning of a PA task with compound stimuli, component-response relearning with one component was superior to relearning with the other component(s); or 2) by showing that, following learning of a PA task with compound stimuli, response recall to one component was superior to recall to the other(s).

Postman and Greenbloom (1967) observed that such measures of cue selection cannot rule out mediation of the correct response, the result being that the magnitude of selection is overestimated, particularly to the non-selected (or non-preferred) components. They proposed that a double-criterion of cue selection be adopted in inferring selection. The two criteria which they proposed are: 1) the subject must be able to recall the correct response to the component, and 2) the subject must be unable to recall the other component(s) of the compound. This double-criterion, as can be seen, effectively rules out mediation. Should these criteria be met, one may infer with some degree of confidence that selection has occurred.

In their original procedure, Postman and Greenbloom (1967) used a between-groups design. Following learning to the compound stimuli, different groups were each presented with a different component and asked to recall, not only the response, but also the associated component(s). One recall group was required for each component. Postman and Greenbloom pointed out that the procedure was not suitable for use with a same-subjects design, as recall to the various components would not be independent.

Berry and Baumeister (1971b) modified the Postman and Greenbloom procedure to apply to a within-subjects design, thus requiring considerably fewer subjects. Instead of presenting a different stimulus component to each group following PA learning with compound stimuli, Berry and Baumeister presented all stimulus components, in random order, to all subjects following PA learning. Selection of a component was inferred when subjects could recall the correct response to only one of the stimulus components.

The most recent innovations in measuring techniques have been advanced by Richardson (1972). Richardson pointed out a number of problems arising from earlier techniques. One problem is that it is difficult to ascertain the extent to which a subject's selection is restricted to one particular component, as opposed to another. Usually, for example, selection of a component is inferred from composite scores. This procedure results in obscuring any selection which might have occurred to the nonpreferred component(s).

To remedy the situation, Richardson proposed a method of quantifying the extent to which a subject adheres to a single cue selection strategy. The measure, which he terms "consistency", is calculated from recall data obtained with a procedure similar to that of Berry and

Baumeister (1971b). That is, all stimulus components are presented individually, in random order, to all subjects and recall of the correct responses is required. Consistency is the number of correct responses to selected components divided by the number of <u>different</u> correct responses multiplied by 100.

A second problem with the earlier procedures, Richardson pointed out, is that the extent to which a subject restricts his attention to a single component, regardless of whether or not it is the same component, cannot be quantified. Richardson proposed a measure, which he calls "efficiency", to accomplish this purpose. Efficiency is obtained from recall data obtained with the same procedure as that used to figure consistency. Efficiency is the number of different correct responses divided by the number of <u>total</u> correct responses times 100.

A third criticism of existing studies offered by Richardson is that most have failed to control for differential component-response difficulty of the various stimulus components. Without this control, demonstrations of differential cue effectiveness for the various stimulus components following PA learning are insufficient to infer differential attention to these components. In these instances, differential cue effectiveness could be as much a result of differential component-response difficulty as to differential attention to these components on the part of the subjects.

The control which Richardson recommended was simply the use of two (or more, depending upon the number of components) single-component groups, each learning a PA list with one of the components as the stimuli. Thus, if stimulus components are shown to be differentially effective as cues following PA learning, differential attention to components may be inferred only if the single-component control groups do not differ in the number of learning trials required to reach the learning criterion.

Statement of the Problem

A considerable amount of research has been generated by Baumeister and his associates regarding the cue selection habits of children and retardates. With a few exceptions (Baumeister & Berry, 1968; Baumeister, Berry, & Forehand, 1969), both retardates and children have been found to process stimulus components similar to normal adults in learning PA tasks with compound stimuli. That is, each will select the more meaningful of two stimulus components (Berry & Baumeister, 1971a, 1973; Lovelace, 1968), each will select the left component in a nonintegrated, multiple-component stimulus (Baumeister & Berry, 1970; Berry *et al.*, 1971; Lovelace & Blass, 1968), and each will select a component if their attention is directed to that component through instructions (Baumeister *et al.*, 1969, Study 3; Houston, 1967).

A recent study performed by Hale and Morgan (1975, Exp. 1), however, offers some indication that differences do exist in the way in which individuals of different developmental levels process components of compound stimuli in PA learning. These researchers required two groups of children, average ages 4.6 and 8.8 years, to learn the spatial positions of five cards (the cards were displayed from left to right on study trials) on which unique color +

form compounds were pictured. After each child had mastered this task, he was presented with a transfer task in which he was asked to recall the position of each of the five cards given only the color or only the shape as a cue. For both age groups, shape was the better of the two cues and both groups performed equally well with the shapes as cues. The older group, however, recalled more correct positions when given the colors as cues than did the younger group. Hale and Morgan concluded that the 8-year-olds had attended more to the color component during task acquisition than had the 4-year-olds. On this basis, these authors suggested that there is an increasing propensity with age (within the age ranges sampled) to attend to secondary stimulus components in a learning task.

The study conducted by Hale and Morgan (1971, Exp. 1) suffered from two shortcomings. First, Hale and Morgan failed to demonstrate that the relative ease with which the shape and color cues were associated with responses during learning was the same for both age groups. Therefore, it is possible that the older subjects did not attend more to the color components than the younger subjects, but simply found them easier to associate with the responses (relative to the shape components).

Second, one cannot rule out the possibility that ceiling effects contributed to the apparent Age x Stimulus Component interaction obtained by Hale and Morgan. Recall to the shape cues during the transfer task was nearly perfect for both age groups. The possibility exists, then, that had a more difficult task been used, the older subjects might have performed better during the recall task with the shape cues than the younger subjects.

The present study was an effort to replicate and extend the findings of Hale and Morgan (1975, Exp. 1). The present study differs from that study in three significant ways. First, retarded subjects of two MA levels were employed rather than normal children of different ages. The reason for employing retarded subjects was simply an interest in the cue processing of retarded individuals.

A second difference was the use of pictorial stimulus compounds--line drawings of animate and inanimate objects (e.g., man + umbrella)--rather than color + form stimulus compounds. Numerous PA studies (e.g., Milgram, 1967; Reese, 1965; Rohwer, Lynch, Suzuki, & Levin, 1967) have demonstrated that if pictorial stimulus and response items are depicted in some form of meaningful interaction, for example, a boy pulling a wagon, they learned more quickly than when depicted in a noninteractive manner, for example, side by side. One implication of such studies is that pictorial stimulus and response items tend to be linked in memory if they are presented to the learner in an interactive context. A logical extension of this implication is that a similar phenomenon should occur if the components of pictorial stimuli were presented to the learner in an interactive context.

That is, there should be a tendency for the components to be linked in memory.

Should such a tendency exist, one would expect subjects to process stimuli with interactively-depicted components more as units than stimuli with noninteractively-depicted components. This difference in processing should be evidenced by faster learning with interactive stimulus components than with noninteractive stimulus components. One would also expect a greater inclination for both components of stimulus compounds to elicit correct responses following learning if the components had been interactively depicted than if they had been noninteractively depicted. The verbal stimuli, words and nonsense syllables, provide an approximate analogy to interactive and noninteractive pictorial stimuli. Findings such as those predicted above have been consistently demonstrated when these two stimuli have been compared (Jenkins, 1963; Musgrave, 1962; Musgrave & Cohen, 1964; Solso & Trafimow, 1970).

These expectations must be qualified, however. While some PA studies (Milgram, 1967; Reese, 1965) have found that all age groups benefited equally from interactive depiction of stimulus and response items, at least two studies (Rohwer, Key, & Guy, Studies A and B, cited by Rohwer, 1973, pp. 34-35) found that older children benefited more than younger children. Thus, extrapolating to the present study, the possibility exists that mental age and stimulus-component depiction may interact, with interactive stimulus-component depiction inducing relatively more unitary processing of stimulus compounds by high-MA subjects than by low MA-subjects.

A third way in which the present study differed from the Hale and Morgan (1975, Exp. 1) study was in the use of single-component control groups to assess the relative ease of associating the two types of stimulus components with the responses. This control has been suggested by Richardson (1972) and, as mentioned earlier, was not employed by Hale and Morgan.

In summary, the present study was intended to investigate two questions: (1) Do retardates exhibit an increasing propensity with MA to utilize redundant stimulus information in learning a PA task with compound visual stimuli? And (2) What is the effect of interactive stimulus-component depiction on the use of stimulus components by retardates in learning a PA task with compound visual stimuli?

Method

General Design

Two independent variables were of interest in the present study, MA (high vs. low) and stimulus condition (interactive vs. noninteractive depiction of components). Interactive depiction of stimulus components (line drawings of animate and inanimate objects) was defined as depiction of the components in spatial relationships which are frequently found in the natural environment. Noninteractive depiction of stimulus components was defined as depiction of one component above the other component (a spatial relationship rarely found in the natural environment). A further defining difference between the two types of depiction was the degree of spatial separation of the components. The degree of separation was always less in the interactive depiction than in the noninteractive depiction.

The experiment was conducted in three phases: PA learning, transfer, and picture identification. Two single-stimulus control groups were included in PA learning as per the suggestion of Richardson (1972). This was done to determine whether transfer results might have been influenced by differences in the ease with which animate and inanimate components were associated with the responses during PA learning. The transfer procedure of Berry and Baumeister (1971b) was followed and inferences of cue processing during PA learning were based upon transfer results. Picture identification consisted of having subjects identify both the compound stimuli and the individual stimulus components. The purpose of picture identification was two-fold: (1) to determine whether the interactive and noninteractive pictures were perceived differently by the high- and low-MA subjects, and (2) to find out whether or not the subjects could label the stimulus components.

<u>Subjects</u>

The subjects were 144 residents of a state institution for the mentally retarded. Prior to participation in the experiment, potential subjects were pretested to determine if they could recognize the written numbers one through six. Only those residents which could recognize these numbers were allowed to participate. Those subjects who passed the pretest were randomly assigned to two compound-stimulus and two single-stimulus conditions. These four conditions corresponded to the four lists, described below, which subjects were required to learn. The subjects in these four groups were, further, for the purpose of analyses, divided into two groups of equal size of high and low MA. Thus, there were eight groups in all.

The mean MA's and CA's of these eight groups may be found in Table 1. Analyses of variance applied to these data indicate only one significant difference, the high-MA groups had reliably higher MA's than the low-MA groups.

Twenty-two subjects were dropped from the experiment due to a failure to reach the learning criterion. A Chi square analysis was applied to the numbers of persons in each of the four stimulus conditions who failed to reach the learning criterion. The results of this analysis indicated that the numbers were not significantly different. Thus, no apparent bias was operating. The mean MA and CA of the subjects who were dropped from the experiment were 5.7 years (SD = 2.1 years) and 25.6 years (SD = 12.6 years), respectively.

Apparatus

The apparatus was a Carousel Kodak slide projector, a Lafayette eight-bank timer, and a viewing screen.

Materials

The materials were four, four-pair PA lists photographed in black and white for presentation by the Carousel slide projector. The stimuli for all lists were the digits 1-4. The object drawings varied from one to three inches in height. The digits were uniformly two inches high. The stimulus and response items were separated by a single transverse black line. The stimulus item always appeared on the left. Stimulus-response pairings were performed on a random basis.

Table 1

Mean MA's and CA's (SD's in Parentheses)

of the Subjects

		Stimulus Condition			
		I	NI	AC	IAC
High-MA Groups	MA	10.7	11.0	11.2	11.1
		(1.6)	(1.3)	(1.7)	(.9)
	CA	22.6	25.2	23.3	23.2
		(6.1)	(10.1)	(7.6)	(8.1)
Low-MA Groups	MA	6.0	6.9	6.4	6.8
		(1.5)	(2.0)	(1.4)	(1.4)
	CA	20.4	22.5	21.0	22.6
		(5.6)	(8.4)	(8.1)	(7.1)

Note. *n* = 18 in each group.

Table 2

Stimulus-Response Pairings

Stimulus: Animate Component	Stimulus: Inanimate Component	Response
Man	Umbrella	1
Cow	Pail	2
Girl	Swing	3
Woman	Stove	4

Procedure

PA learning. Subjects were randomly assigned to one of the two compound-stimulus or two-single stimulus conditions upon their appearance in the laboratory. The subjects assigned to condition, or list, NI were randomly assigned to NI 1 or NI 2. As each subject entered the room, he was seated in front of the viewing screen and read PA instructions (see Appendix II). Instructions included presentation of a two-pair PA practice list, using the slide projector, which the subject was required to master to a criterion of one perfect trial. The practice list was similar in nature to the four-pair PA list which the subject was to receive in PA learning and was composed of the following stimulus-response pairs: boy and/or drum: 5 and bird and/or limb: 6. The exact stimulus composition of the pairs was dependent upon the stimulus condition to which the subject had been assigned. Each subject was shown a practice list in which the number, type, and depiction of stimulus components were the same as that which he was to receive during PA learning. Presentation of the practice list was by the anticipation procedure and presentation rate was experimenter-paced.

Following mastery of the practice list, each subject was presented with the appropriate four-pair PA list, again using the slide projector, and was required to master this list to a criterion of two consecutive perfect trials. The anticipation procedure was used to present the four-pair list with a 4:4 presentation rate (the stimulus was presented for 4 seconds followed by presentation of the stimulus and response for 4 seconds), a .6 second inter-item interval, and an 8 second inter-trial interval. Four presentation orders were used to prevent serial learning. One-fourth of the subjects in each group began PA learning on each order.

During the PA learning phase of the experiment, the experimenter did not refer to the stimulus components by name, but always used the term "picture" when referring to a particular stimulus. The purpose of this was to minimize the probability of biasing a subject's natural responses in learning the PA task.

Each subject was allowed approximately one hour to complete the PA learning phase of the experiment. Although this deviates from the usual practice of allowing subjects a specified number of trials to reach a learning criterion, it was felt that allowing subjects the maximum amount of time possible to reach the learning criterion would result in a smaller number of subjects being dropped from the experiment. Thus, while the procedure may have introduced some bias into the selection process, it was deemed that the amount of bias introduced would be small and would be compensated for by an increase in the generality of the results.

Transfer. Approximately one minute following PA learning, subjects assigned to conditions I and NI were presented, by projector, the individual stimulus components, one at a time, and asked to recall the appropriate responses. No feedback regarding the correctness of a response was given to the subjects during the transfer phase of the experiment. Presentation of stimulus components in recall was randomized and two presentation orders were used. Subjects were randomly assigned to one of two orders. Presentation rate during transfer was subject-paced.

Two measures were obtained from the transfer data. One measure was the number of correct responses made during transfer. The primary purpose of this measure was to determine whether the subjects had selected animate or inanimate components (or neither) in learning the PA lists. Had subjects selected either of these components, then the selected component should have elicited more correct responses than the nonselected component during transfer.

A second measure was the proportion of stimulus-component pairs which elicited two correct responses during transfer. In transfer, a subject could respond correctly to both components of a stimulus-component pair, to one component, or to neither component. Only those pairs which elicited at least one correct response were included in the proportion. It was hoped to determine from these proportions the extent to which the four compound-stimulus groups engaged in two-component problem solving during PA learning.

Picture identification. After the PA learning and transfer procedures had been completed, subjects in conditions I and NI were shown their respective stimulus items (the actual drawings from which the slides had been made), one at a time, and asked the question "What is this a picture of?" The same procedure was followed with the subjects in conditions AC and IAC following PA learning, with the exception that half the subjects in each of these conditions were asked to identify the interactive pictures and half were asked to identify the noninteractive pictures. Responses were recorded exactly and the number of high- and low-MA subjects using one or more relational connectives to connect the components of stimulus pictures were tabulated for interactive and non-interactive pictures separately. A relational connective was defined as a verb or preposition. This definition is in keeping with the definition used by Rohwer and his associates in research with interactive stimulus and response pictures (for a review, see Rohwer, 1973).

All subjects who failed to specifically identify both stimulus components when shown the compound pictures were, after all four compound pictures had been shown to them, asked to identify those components which they had not identified. The number of correct component identifications was recorded for each subject. From these data, the numbers of persons in each group who correctly identified all stimulus components were computed and served as an indicant of each group's ability to label the stimulus components. Approximately one minute elapsed between the end of the previous phase of the experiment (transfer for subjects in conditions I and NI and PA learning for subjects in conditions AC and IAC) and the beginning of the picture identification phase.

Results

PA Learning

The number of trials to reach the learning criterion was the dependent measure obtained from PA learning. These data are exhibited in Table 3. A 2 (MA) x 4 (Stimulus Condition) analysis of variance was performed on the trials-to-criterion scores. Only one significant difference was found: high MA subjects required significantly fewer trials to reach the learning criterion than low MA subjects ($F_{1,136} = 15.69$, $p < .001$). All other differences were nonsignificant (F's < 1).

It would appear from the results of the analysis of variance that stimulus condition had little effect on the speed of PA learning. Nevertheless, further analyses of the trials-to-criterion scores of the high-MA groups were undertaken as there were some *a priori* expectations regarding these data. First, it was expected that the high-MA subjects who learned with interactive stimulus components would require fewer learning trials than the high-MA subjects who learned with noninteractive stimulus components. This expectation was supported with a directional t test ($t = 1.99$, $p < .05$, $df = 34$).

Second, and for the same reasons, it was expected

Table 3

Mean Trials-to-Criterion Scores

Obtained During PA Learning

(SD's in Parentheses)

	Stimulus Condition			
	I	NI	AC	IAC
High-MA Subjects	8.4	12.6	11.6	10.8
	(5.2)	(6.9)	(7.7)	(8.2)
Low-MA Subjects	18.7	17.5	17.5	17.3
	(11.0)	(11.6)	(13.5)	(13.5)

Note. *n* = 18 in each group.

that the high-MA subjects who learned with noninteractive components would require more learning trials than the high-MA subjects who learned with single-component stimuli. For this comparison the two high-MA, single-component groups were combined. This difference was not significant ($t < 1$).

Third, and, again, following the same reasoning, it was expected that the high-MA subjects who learned with interactive stimulus components would require about the same number of learning trials, or perhaps a few more learning trials, than the high-MA subjects who learned with single-component stimuli. For this comparison, as for the previous comparison, the two high-MA, single-component groups were combined. This difference was also not significant ($t = 1.35$, $df = 51$, $p > .10$).

Transfer

The data from the two recall orders were combined for the following analyses of transfer data. Recall order was not found to exert a significant effect on either dependent variable, nor was it found to interact with any independent variable (all F's < 1.36, all p's > .20).

The mean numbers of correct responses made during transfer may be found in Table 4. A 2 (MA x 2 (Stimulus Condition) x 2 (Stimulus Component) mixed analysis of variance performed on these data (see Table 5) indicates two significant effects, a significant stimulus condition

Table 4

Mean Numbers of Correct Responses Made during Transfer (SD's in Parentheses)

Stimulus Condition	I		NI	
Stimulus Component	Animate	Inanimate	Animate	Inanimate
High-MA Subjects	3.1	3.3	2.2	2.4
	(1.0)	(.7)	(1.5)	(1.1)
Low-MA Subjects	2.6	2.3	2.4	2.5
	(1.2)	(.9)	(1.2)	(1.0)

Note. *n* = 18 in each group.

Table 5

Summary of Analysis of Variance Performed on the Numbers of Correct Responses Made during Transfer

Source	*df*	*MS*	*F*
Between			
MA (A)	1	4.00	2.35
Stimulus Condition (B)	1	7.11	4.18*
AB	1	8.03	4.72*
Residual	68	1.70	
Within			
Stimulus Component (C)	1	.25	< 1
AC	1	1.00	1.35
BC	1	.45	< 1
ABC	1	.24	< 1
Residual	68	.74	

* $p < .05$

effect (F 1,68 = 4.18, p < .05) and a significant MA x Stimulus Condition Interaction (F 1,68 = 4.72, p < .05). Stimulus component was not a significant variable (F < 1), nor did it interact with any other variables (F's < 1.35, p's > .20). The latter finding means that the four compound-stimulus groups did not select either the animate or the inanimate components during PA learning. It is possible that individuals may have selected one or the other of these components, however, as individual selection patterns are obscured by the group means.

The data from the two stimulus components were combined for analyses of simple effects. The combined data are depicted in Figure 1. Analyses of simple effects show that the High MA-Condition NI, Low MA-Condition I, and Low MA-Condition NI groups did not significantly differ in the mean numbers of correct responses made during transfer (all t's < 1). Therefore, these groups were combined and compared to the High MA-Condition I group. The High MA-Condition I group was found to have yielded a significantly higher mean number of correct responses during transfer than did the other three groups (t = 3.19, p < .01, df = 68). For this comparison a pooled error term was used and the test of significance was nondirectional.

The proportions of stimulus-component pairs which elicited two correct responses during transfer may be

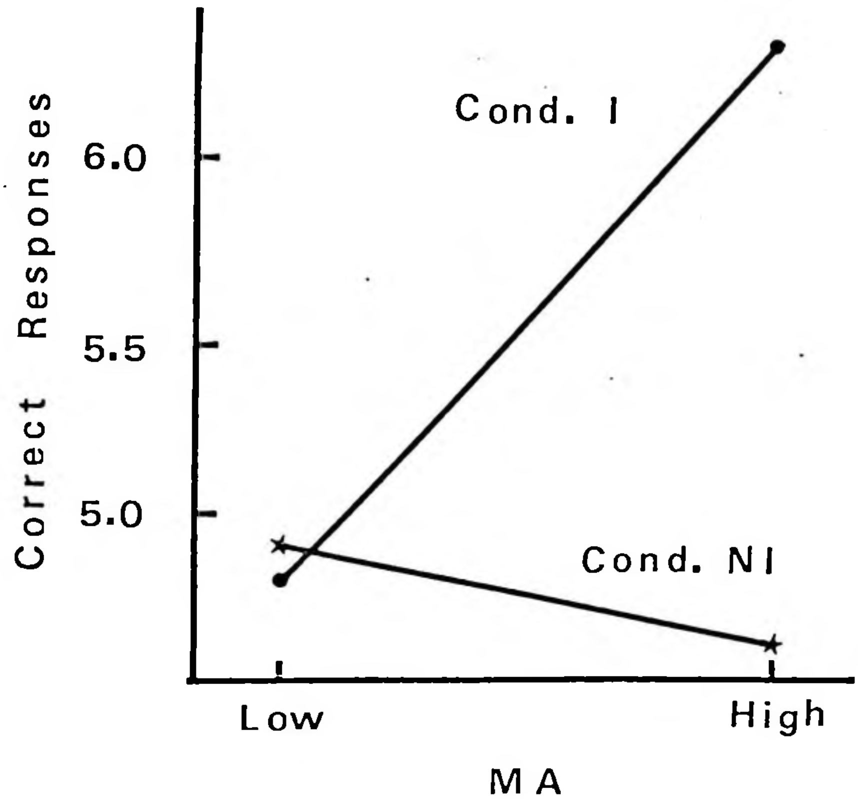

Fig. 1. Mean numbers of correct responses made during transfer.

found in Table 6. They are also graphically portrayed in Figure 2. A 2 (MA) x 2 (Stimulus Condition) analysis of variance conducted on these data (see Table 7) indicates two significant effects. The effect of MA was significant (F 1,68 = 4.18, p <.05) and the MA x Stimulus Condition interaction was significant (F 1,68 = 4.45, p <.05).

Since the interaction was significant, analyses of simple effects were performed. The High MA-Condition NI, the Low MA-Condition I, and the Low MA-Condition NI groups were found not to significantly differ in the proportions of stimulus-component pairs eliciting two correct responses during transfer (t's < 1). Therefore, these groups were combined for a comparison with the High MA-Condition I group. The High MA-Condition I group was found to have a significantly higher proportion of these pairs than the combined groups (t = 2.91, p <.01, df = 68). For this analysis a pooled error term was used and the test of significance was two-tailed.

The proportion data suggest that the high MA-subjects who learned with interactive stimulus components engaged in proportionately more two-component problem solving during PA learning than the other three groups. It could be argued, however, that this group yielded a higher proportion of stimulus-component pairs eliciting two correct responses because this group learned the PA task faster. Thus, the stimulus-response pairs were better learned and

Table 6

Proportions of Stimulus-Component Pairs

Which Elicited Two Correct

Responses during Transfer

(SD's in Parentheses)

	Stimulus Condition	
	I	NI
High-MA Subjects	.71 (.27)	.46 (.37)
Low-MA Subjects	.39 (.30)	.46 (.33)

Note. *n* = 18 in each group.

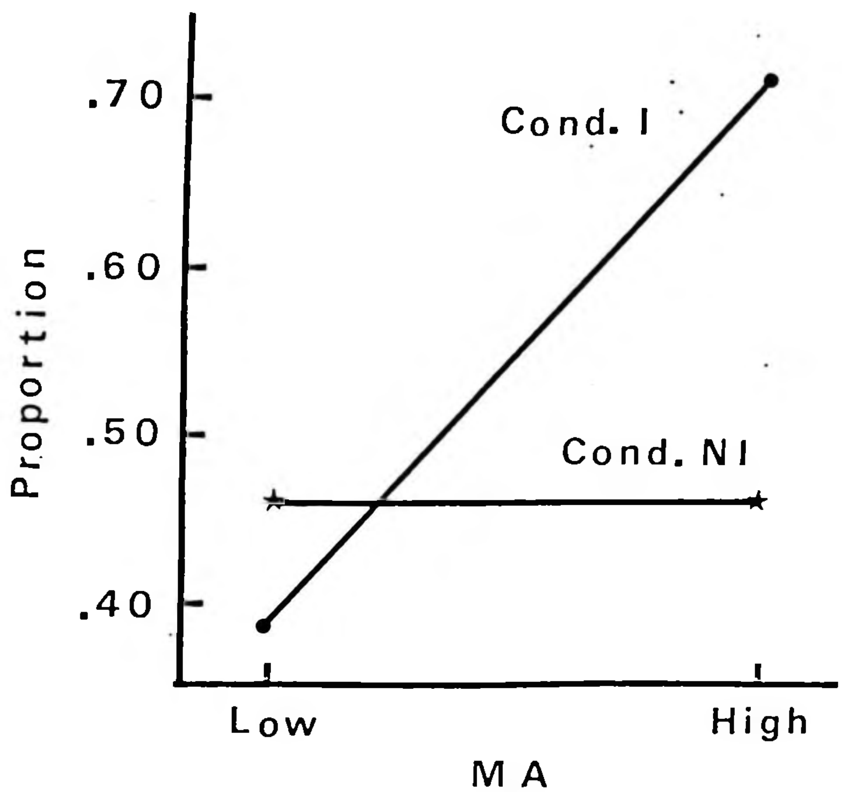

Fig. 2. Proportions of stimulus-component pairs which elicited two correct responses during transfer.

Table 7

Summary of Analysis of Variance Performed on Proportions of Stimulus-Component Pairs Which Elicted Two Correct Responses during Transfer

Source	df	MS	F
MA (A)	1	.46	4.18*
Stimulus Condition (B)	1	.15	1.36
AB	1	.49	4.45*
Residual	68	.11	

* $p < .05$

less component-response forgetting occurred prior to the transfer task (for a discussion of this problem, see Belmont, 1966).

To investigate this possibility, partial correlations were obtained between the MA's and proportion scores of the subjects in condition I and NI, separately, with the effects of learning speed (trials-to-criterion scores) partialed out. The obtained partial correlations were +.40 and +.05 for the subjects in conditions I and NI, respectively. The former correlation is significantly different from 0 ($t = 2.35$, $p < .05$, $df = 33$), whereas the latter correlation is not ($t < 1$). (The formula for the test of significance was that suggested by Ferguson, 1971, pp. 391-392.) Therefore, even with the effects of speed of learning removed, there is still a significant linear relationship between MA and the proportion of stimulus-component pairs eliciting two correct responses for those subjects learning with interactive stimulus components.

Picture Identification

The numbers of persons using one or more relational connectives to connect the components of stimulus pictures may be found in Table 8. Since the data from both compound- and single-stimulus learning groups went into each cell, these frequencies were compared before combining to determine if they were compatible. In no case did chi square exceed 2.25 ($p > .10$). Separate chi square analyses were applied

Table 8

Numbers of Persons Using One or More Relational Connectives to Connect the Components of Stimulus Pictures during Picture Identification

	Stimulus Picture	
	Interactive	Noninteractive
High-MA Subjects	23	9
Low-MA Subjects	16	6

to the numbers of persons within each MA level. The results of these analyses indicated that more persons used relational connectives in describing noninteractive pictures. This was true of both MA levels. The obtained chi square values were 6.12 ($p < .02$, $df = 1$) and 4.55 ($p < .05$, $df = 1$) for the high- and low-MA levels, respectively. These results suggest that both the high- and low-MA groups perceived the interactive stimulus components as more interactive than the noninteractive stimulus components.

The numbers of persons in each of the eight groups who correctly identified all eight stimulus-component pictures are exhibited in Table 9. These numbers were compared using a chi square analysis and found not to significantly differ ($x^2 < 1$). It may be concluded that the eight groups were nearly equivalent in their abilities to label the stimulus components.

Table 9

Numbers of Persons Correctly Identifying All Stimulus Components during Picture Identification

	Stimulus Condition			
	I	NI	AC	IAC
High-MA Subjects	18	18	14	18
Low-MA Subjects	14	16	15	11

Discussion

The transfer findings obtained with the subjects who received interactive stimulus components during PA learning closely parallel the findings obtained by Hale and Morgan (1975, Exp. 1) with normal children. Therefore, it would appear that the mental development of both retardates and normal children can be characterized by an increasing propensity to utilize redundant stimulus information in the formation of stimulus-response associations when the stimuli are composed of interactive visual components.

The transfer findings obtained with the subjects who received noninteractive stimuli during PA learning fail to demonstrate a similar developmental process. This poses the question of whether this failure was due to the intellectual deficit of the subjects, or to the noninteractive nature of the stimuli. While this question cannot be answered definitively, most studies to date have found that retardates and normals manifest similar patterns of cue utilization during PA learning, suggesting the latter alternative as the more parsimonious explanation. This explanation is also supported by data from an unpublished study performed by the present author. The study was similar to that conducted by Hale and Morgan, except that the color and form components of the stimuli were separated (color surrounding form) rather than integrated (colored forms), as in the latter experiment.

The transfer results are generally consistent with the predictions derived from the Rohwer et al. studies (Rohwer, 1973). These results support a view that interactive, as contrasted with noninteractive, stimulus-component depiction produces increased utilization of the stimulus compounds by retardates, with the degree of increase being inversely related to the developmental level of the retardate. However, contrary to the predictions generated by this study, interactive stimulus-component depiction did not produce any increased utilization of stimulus compounds by low-MA subjects. The reason for this discrepancy is not clear. However, it could easily be due to differences in processing stimulus-stimulus and stimulus-response information.

The failure of the subjects in the compound-stimulus groups to predominantly select either the animate or the inanimate components as functional stimuli during PA learning prevents the inference that the differences obtained in transfer were the result of attentional variations during PA learning. For example, even though the high-MA subjects who learned with interactive stimulus components were more frequently able to recall the correct responses to both components of stimulus-component pairs during transfer, it does not necessarily follow that this was the result of greater attention to both components by these subjects. An alternative hypothesis is that all subjects attended to both stimulus components with equal frequencies, but that the high-MA subjects who received interactive components were able to encode or decode the individual component-component or component-response associations more efficiently. Had these subjects selected either the animate or inanimate objects as their functional stimuli during learning, then the differences which occurred during transfer could have been attributed to differences in attentional patterns, as both MA groups performed equally well during PA learning with either the animate or the inanimate components as stimuli. As was noted previously, a similar problem exists in the Hale and Morgan study (1975, Exp. 1).

Taken as a whole, the results of the present experiment can be interpreted to indicate that mental development, at least that of retardates, can be characterized by an increasing ability to utilize interactive visual stimuli. This interpretation is indicated by the finding that interactive depiction of stimulus components facilitated learning of the PA list by the high-MA retardates, but did not facilitate learning of the PA list by the low-MA retardates. Still unanswered, however, is the question of why this is true. One appealing possibility is that the high-MA subjects, when presented with the interactive stimulus components, produced mediators which facilitated learning. The low-MA subjects, on the other hand, either failed to produce such mediators, or else produced mediators which failed to facilitate learning.

The possibility that the subjects may have produced mediators to the stimuli during PA learning raises a question regarding the appropriateness of the cue selection paradigm in studying the processing of complex sitmuli. Berry, Duncan, and Cole (1974) have reported evidence which suggests that the cue selection paradigm may not be entirely appropriate for studying the processing of such simple stimuli as CCC's. Berry _et al_. had college students learn a CCC:digit PA task, following which the subjects were questioned regarding how they had associated the stimulus and response items. These subjects reported using verbal mediators to solve 40% of the PA pairs, whereas selective rehearsal of single letters was reported as a strategy in solving only 34% of the pairs. The results of Berry _et al_. suggest that mediation plays a large role in the learning of stimulus-response pairs, even when the stimuli are relatively simple compounds.

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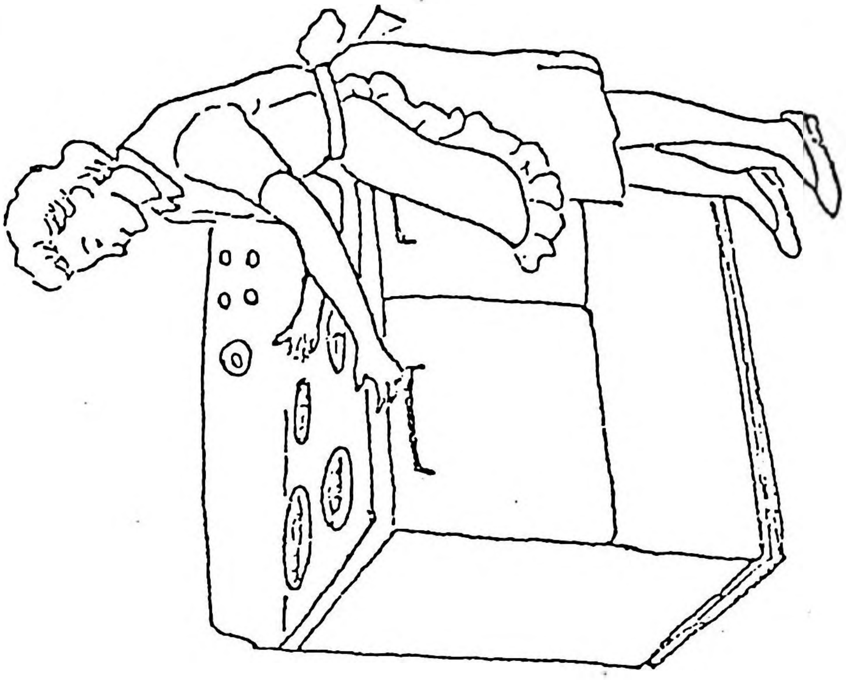
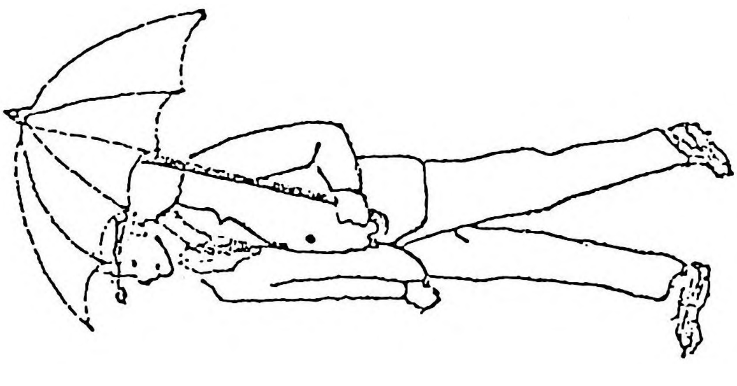
Appendix I

Stimulus Pictures

List I





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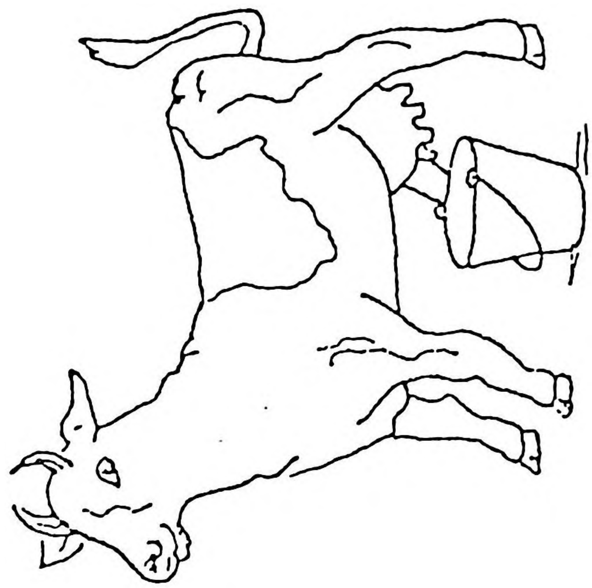

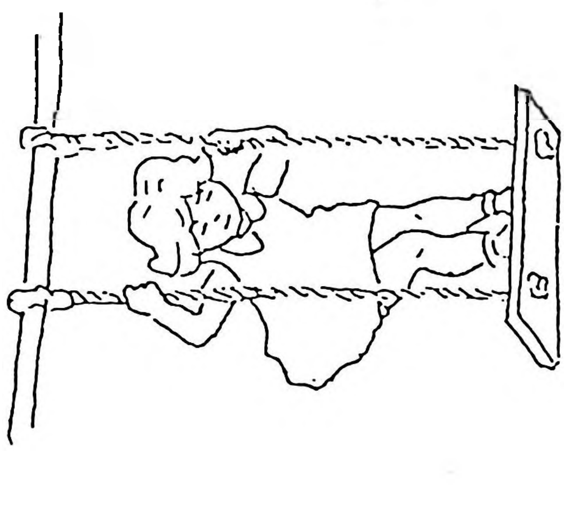

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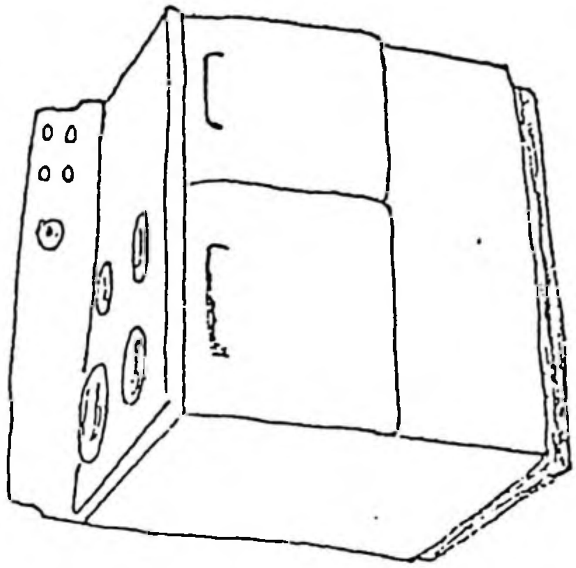

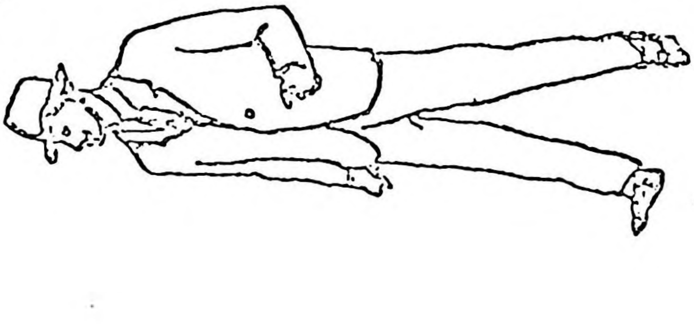

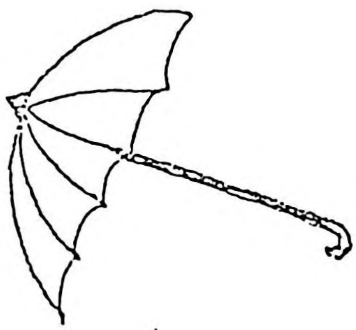

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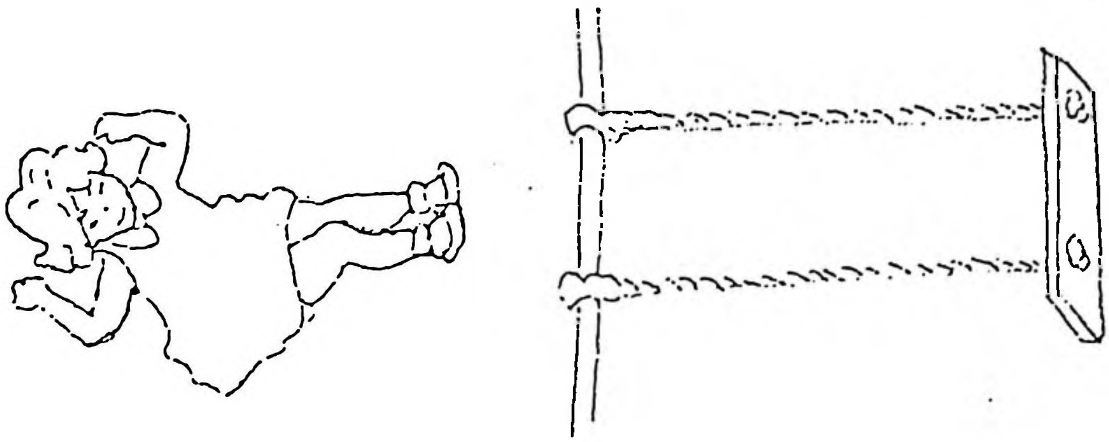

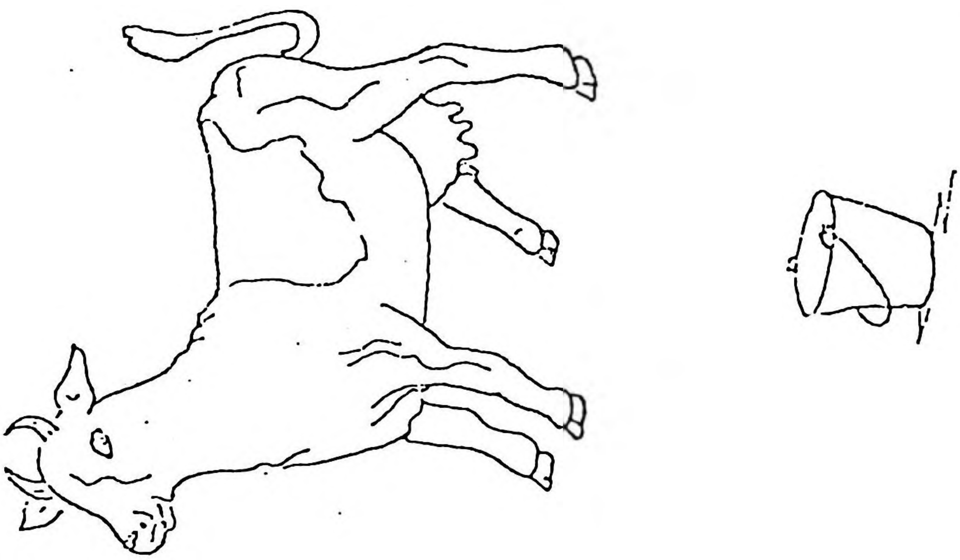

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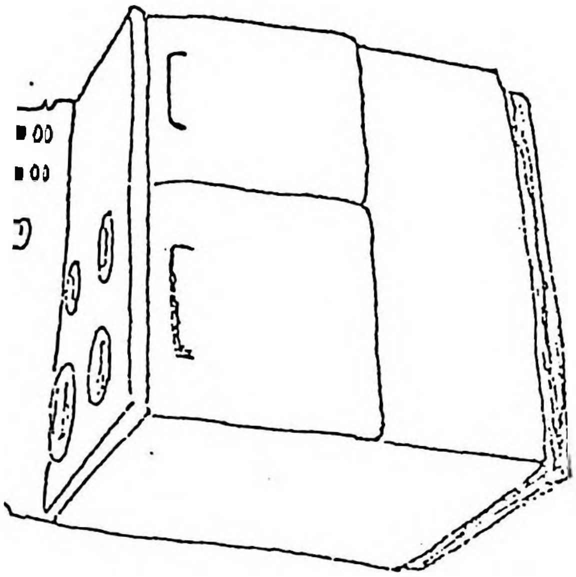

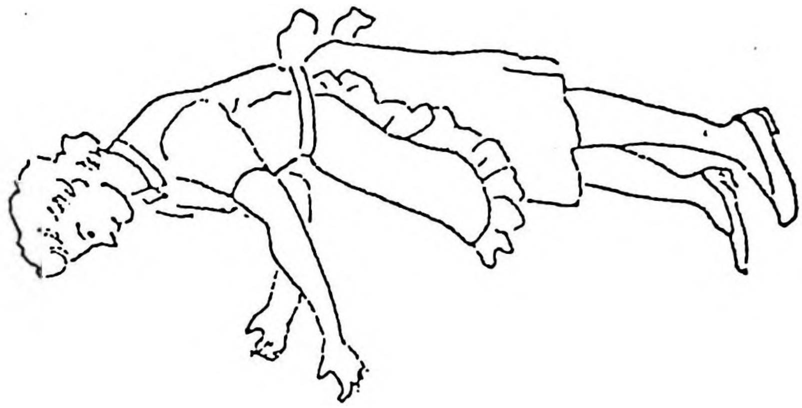

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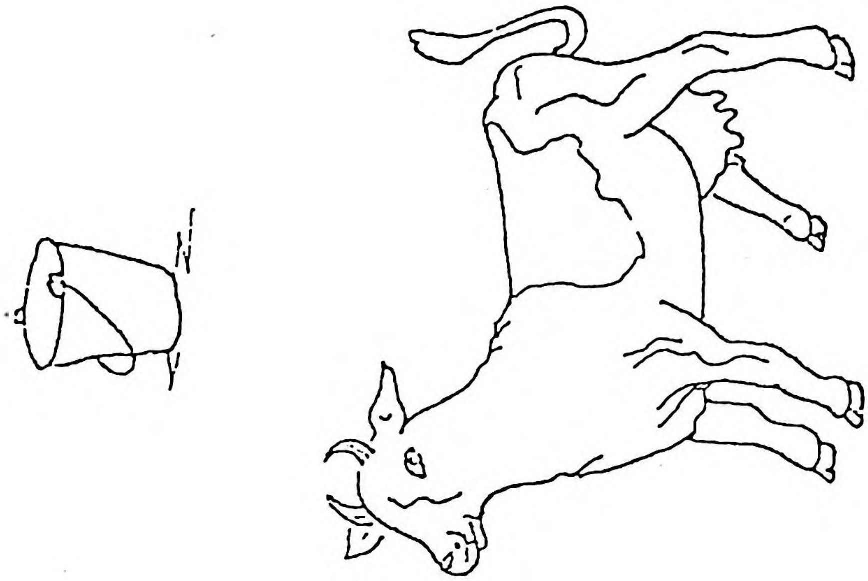
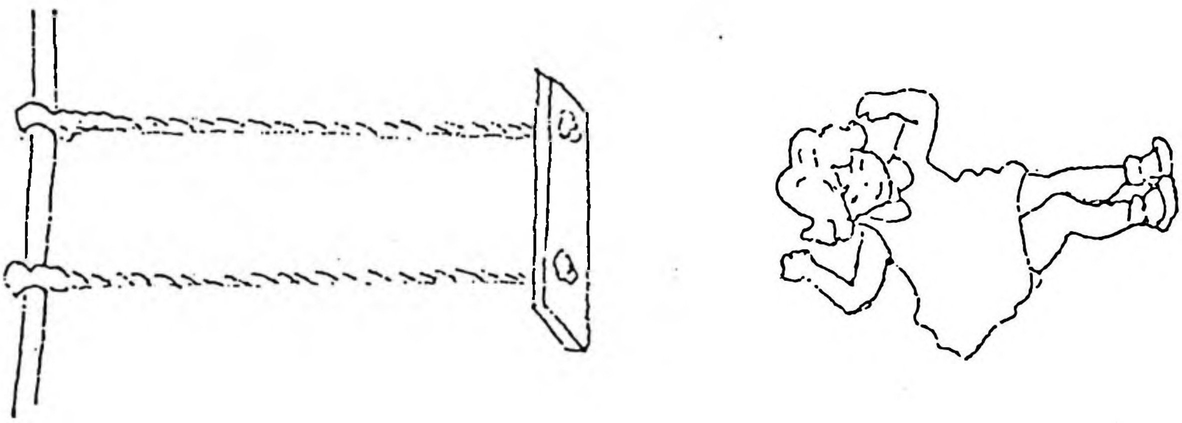
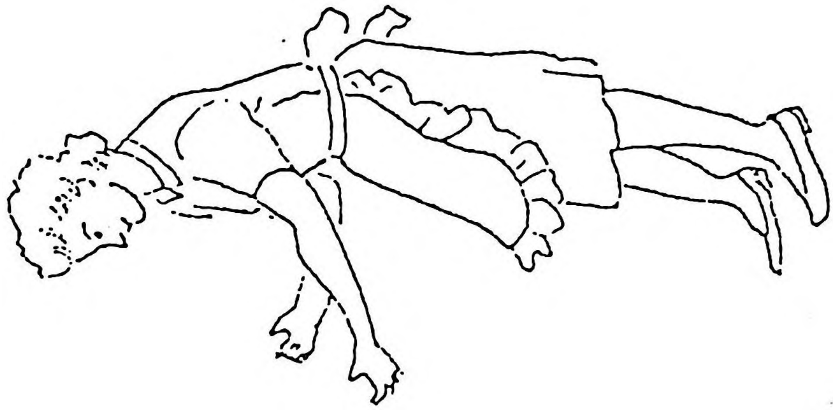
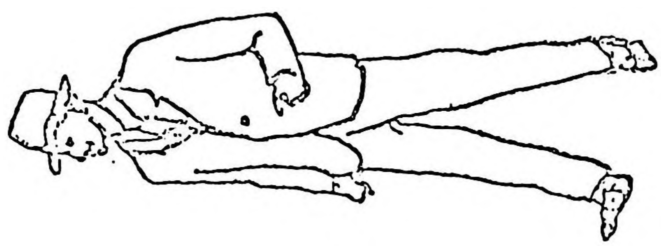




List AC





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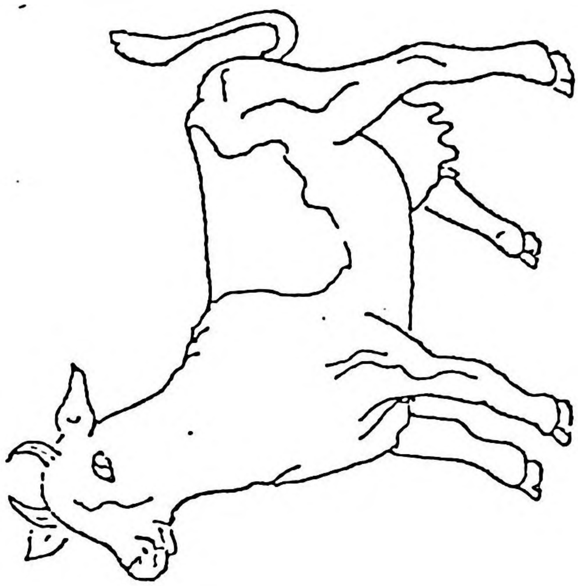
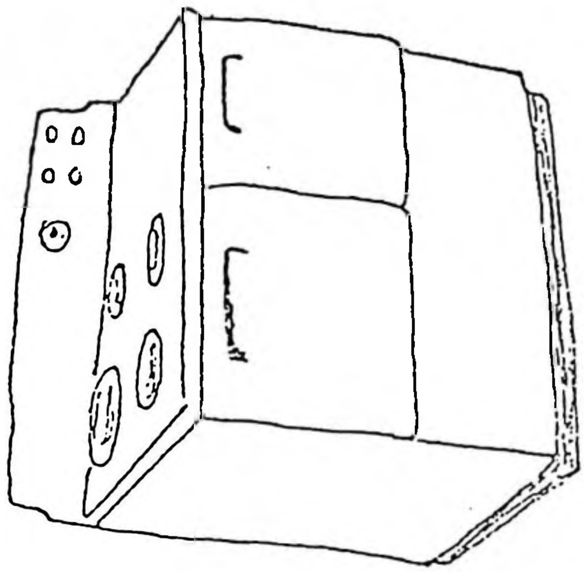
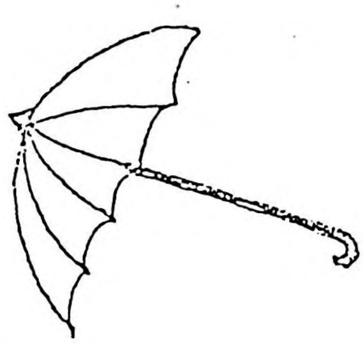


List IAC





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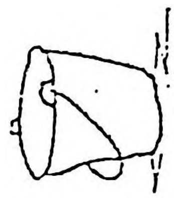

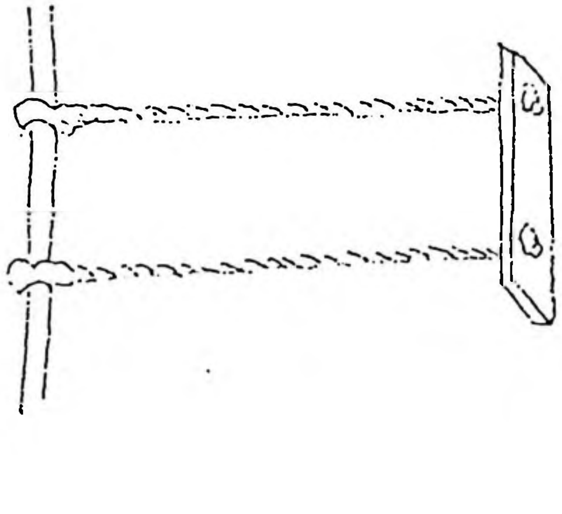

Appendix II

Instructions

PA Learning

This is an experiment to see how well you can remember pictures and numbers that go together. You will see them on this screen. First, you will see one picture, and then you will see the same picture and the number that goes with it. Your job is to remember which pictures and numbers go together.

Each time you see a picture, I want you to tell me what number goes with it before you see the picture and number together. At first you may make some mistakes, but, if you watch carefully, you will be able to remember which pictures and numbers go together. I will let you see them several times so that you can learn all of the pictures and numbers that go together. Do you think you understand?

Let's just try one as an example:

1. boy/drum: 5
2. bird/limb: 6

(Each subject was shown examples via the slide projector, in which the number, type and depiction of stimulus components were the same as that which he was to receive in paired-associates learning. Practice learning was taken to a criterion of one perfect trial.)

Alright, you seem to have the idea. Are you ready to begin?

Transfer

You have just learned that certain pictures go with certain numbers. Each picture that goes with a number is a picture of two objects. Now I am going to show you each object, by itself, and I want you to tell me what number goes with it. It will be the same number that went with it before. Do you think you understand? Are you ready to begin?

Appendix III

Raw Data

MA's of Subjects

	Stimulus Condition							
	I		NI		AC		IAC	
	14.0	10.1	13.5	10.5	14.8	10.9	12.3	11.2
	13.9	9.8	12.9	10.3	13.4	10.7	12.0	11.2
	12.9	9.7	12.8	10.1	12.9	10.5	12.0	11.2
	12.2	9.5	12.2	10.0	12.8	10.3	12.0	11.1
High-MA Subjects	11.8	9.3	12.0	9.9	12.8	9.7	11.8	10.8
	11.8	9.2	12.0	9.8	12.5	9.5	11.8	10.2
	11.0	9.2	11.7	9.8	11.8	9.0	11.6	9.9
	10.5	9.2	11.4	9.5	11.6	9.0	11.6	9.9
	10.4	8.8	10.8	9.3	11.2	8.4	11.2	8.6
	8.8	5.8	9.2	6.9	8.2	6.0	8.4	7.0
	8.5	5.4	9.0	6.8	3.2	5.9	8.4	6.5
	7.5	5.2	8.9	6.5	8.2	5.8	8.2	6.5
	7.4	5.2	8.9	5.7	7.8	5.8	8.2	6.0
Low-MA Subjects	7.0	5.2	8.6	5.2	7.7	5.5	8.2	5.4
	6.9	4.7	8.2	5.2	7.6	5.3	7.9	5.2
	6.5	4.6	8.2	4.3	7.4	4.8	7.8	4.9
	6.4	3.9	8.2	3.2	7.4	4.3	7.8	4.4
	6.0	3.0	7.7	3.1	6.4	3.1	7.7	4.1

CA's of Subjects

	Stimulus Condition							
	I		NI		AC		IAC	
High-MA Subjects	16.9	16.3	20.9	23.4	18.9	49.7	24.9	22.1
	17.2	30.1	19.7	18.0	19.0	18.1	22.9	25.8
	17.9	27.6	43.1	49.8	18.4	26.4	19.8	17.2
	19.7	25.0	18.0	17.2	26.9	18.9	19.7	23.2
	20.2	38.0	19.5	18.8	19.2	20.8	17.0	24.8
	23.4	16.0	18.2	28.9	20.8	17.2	24.7	20.1
	23.2	23.4	16.3	23.6	23.6	22.2	18.2	17.2
	17.8	31.8	17.2	30.7	16.9	32.9	18.3	30.8
	26.2	17.1	44.3	25.2	25.9	24.3	18.8	52.9
Low-MA Subjects	22.5	20.1	29.7	15.9	36.9	27.5	36.9	16.0
	26.9	16.8	16.7	15.4	26.8	15.8	30.6	13.8
	24.8	25.7	17.8	21.2	17.5	29.2	22.9	34.2
	18.1	17.5	32.7	27.8	18.8	22.8	23.2	14.1
	32.8	26.8	47.5	19.5	20.2	13.8	23.2	25.0
	16.8	15.1	26.3	18.3	14.2	14.2	16.5	21.9
	27.2	16.6	25.4	26.5	37.5	15.0	17.1	15.6
	14.6	15.1	24.2	12.9	29.9	12.3	25.7	22.2
	19.5	10.9	16.1	11.7	16.1	10.4	14.7	32.9

Trials-to-Criterion Scores (PA Learning)

	Stimulus Condition							
	I		NI		AC		IAC	
High-MA Subjects	4	5	8	5	16	16	3	4
	7	5	6	9	5	9	4	8
	10	7	11	28	6	5	3	22
	4	5	8	10	9	17	17	11
	4	26	11	13	3	26	7	7
	10	6	15	8	3	3	20	10
	10	10	7	15	28	16	5	32
	4	14	9	30	13	21	6	10
	8	12	21	12	7	6	3	23
Low-MA Subjects	26	13	25	14	32	11	36	14
	31	10	19	18	12	6	6	25
	13	9	13	46	5	13	5	15
	6	22	9	40	16	47	8	23
	9	20	8	9	54	10	13	19
	30	9	20	13	17	14	10	23
	20	23	12	36	27	6	8	3
	8	52	4	14	12	7	5	12
	20	15	8	7	13	13	26	60

Correct-Response Scores (Transfer)

Stimulus Condition	I		NI	
Stimulus Component[a]	Animate	(Inanimate)	Animate	(Inanimate)
High-MA Subjects	3(4)	4(4)	4(4)	1(2)
	4(3)	4(2)	4(4)	0(1)
	2(3)	4(4)	3(1)	1(2)
	3(3)	3(3)	1(2)	4(3)
	3(2)	3(3)	2(2)	2(1)
	4(4)	3(3)	1(3)	1(1)
	4(4)	3(4)	2(3)	4(3)
	0(4)	2(3)	4(4)	0(2)
	4(3)	3(4)	4(4)	1(2)
Low-MA Subjects	4(2)	4(3)	2(2)	3(4)
	3(2)	1(2)	2(2)	0(2)
	4(3)	3(1)	3(2)	1(1)
	2(3)	1(2)	3(4)	1(3)
	4(2)	2(1)	4(3)	2(3)
	1(2)	2(2)	1(1)	2(1)
	4(2)	2(3)	4(3)	3(2)
	4(4)	2(1)	4(4)	3(3)
	1(2)	2(4)	4(2)	1(3)

[a] Stimulus Component is a within-subject variable.

Component-Identification Scores (Picture Identification)

	Stimulus Condition			
	I	NI	AC	IAC
	8 8	8 8	4 8	8 8
	8 8	8 8	8 8	8 8
	8 8	8 8	8 7	8 8
	8 8	8 8	8 8	8 8
High-MA Subjects	8 8	8 8	8 4	8 8
	8 8	8 8	8 8	8 8
	8 8	8 8	8 8	8 8
	8 8	8 8	8 8	8 8
	8 8	8 8	0 8	8 8
	8 7	8 8	8 8	0 8
	8 7	8 7	8 8	8 6
	8 8	8 8	8 7	8 7
	8 8	8 8	8 8	8 7
Low-MA Subjects	8 8	8 8	8 8	6 8
	8 6	8 8	7 7	8 7
	8 7	8 8	8 8	8 8
	8 8	8 7	8 8	8 8
	8 8	8 8	8 8	8 0